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CURRENT LITERATURE

BOOK REVIEWS

Heredity as an exact science

Problems of evolution have taken a dominant place in biology ever since the appearance of DARWIN'S *Origin of species.* During the latter part of the last century there was little important progress made, though there was an abundance of academic discussion and repeated analysis of data recorded by DARWIN and a few other observers; but already in the closing years of the century a reaction had set in. With the beginning of the present century this reaction reached its first important expression with the appearance of DE VRIES'S *Mutationstheorie,* which marked the beginning of a new epoch in the study of the various factors of evolution, an epoch not inappropriately called the "era of *experimental* evolution." Other branches of biology have exhibited at the same time a corresponding development. Instead of pure speculations, and of generalizations from observations uncontrolled by experimental conditions, there has been a swiftly growing demand for greater exactness in observations and for experimentation.

As an essential part of the reaction, the development of mathematical methods by Professor KARL PEARSON and a few others promised for a time the key to the riddles of evolution. This movement, led by a pure mathematician, developed a series of beautiful methods for the mathematical analysis of data and the comparison of variations. These methods are of the greatest importance when rightly used, but owing to the almost invariable lack of an equally keen *biological* analysis, the applications of these methods have led to a largely spurious product, whose showing of depth and accuracy has been illusive, not because the methods are faulty, but because of their application to data which did not supply the one fundamental assumption of homogeneity upon which the whole biometrical system is based.

Parallel with this movement toward the use of mathematically precise methods, there has been a rapidly increasing utilization of pedigree culture, or genetic methods involved in efforts to distinguish between mutations and fluctuations, and in Mendelian investigations in heredity, which methods lay stress chiefly upon biological analysis. The antagonism of active workers with biometric and genetic methods in the study of heredity scarcely permitted it to be hoped that a work might soon appear which would give a sound and well-balanced treatment of heredity, utilizing the results gained by both biometry and genetics. On the one hand were the mathematical writings of Professor PEARSON and a number of his students, in which mathematical methods are applied to data without a preliminary biological analysis to determine whether they were indeed homogeneous, as they were assumed to be; on the other hand, the writings of Professor BATESON and many others dealt purely with alternative types so different from each other that they could be classified by ordinary inspection, and ignored entirely the fundamental value, and indeed the necessity, of biometrical methods in the study of less divergent types.

It has remained for Dr. JOHANNSEN[1] of Copenhagen, himself an ardent student of quantitative variation by biometrical methods, harmoniously to combine the mathematical analysis with a biological analysis of his material, that enables him to present a thoroughly well-balanced treatment of heredity and variation in the light of all these recent refinements of method. His book is presented in the form of twenty-five lectures, which give the clearest and simplest discussion of the statistical methods and their exact significance which has yet appeared. His full, elementary, and illuminating explanations of all the biometrical methods, with simple examples showing their usefulness and their limitations, are a noteworthy contribution, since they render an otherwise difficult and to many persons distasteful subject easily intelligible to anyone who will seriously undertake its mastery. While explaining the meaning of all the biometrical methods and their importance in the exact investigation of variation and heredity, the author continually lays stress upon the fact that these methods are instruments whose usefulness depends upon the quality of the data to which they are applied. Much attention is given to irregular, one-sided, or bimodal variation curves, and it is shown that these different types of curves may be produced by any one of several different causes, and that therefore the occurrence of such curves gives no indication of the interpretation which is to be placed upon them. The interpretation must always come by biological analysis.

The biological conception which forms the keynote of the author's entire discussion is *the permanence of the elementary types* which collectively make up all the systematic species of plants and animals. This is essentially the same conception as the "elementary species" of DEVRIES, but by JOHANNSEN it is given an experimental support of such consistency and magnitude as to place it upon a much firmer basis than it has had heretofore. The existence of such permanent types was first given a biometrical demonstration by JOHANNSEN in his *Ueber Erblichkeit in Populationen und in reinen Linien* (1903), and the present work is in large measure an elaboration and application of the conclusions reached in that paper, supported by the results of a number of added generations and additional critical experiments.

The author's keen analysis of the different kinds of types is having a large influence upon present discussions of heredity and evolution. For the elementary forms—whether "elementary species" or "varieties" in the DeVriesian sense—he has proposed the convenient term *biotypes*. He also distinguishes them as *genotypes*, that is, collections of individuals having like germinal characters to distinguish them from mixtures of individuals having like external characters, but of unlike germinal composition. To these latter mixtures, whose uniformity is only apparent, he gives the name *phenotypes*.

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[1] JOHANNSEN, W., Elemente der exacten Erblichkeitslehre. Deutschen wesentlich erweiterte Ausgabe in fünfundzwanzig Vorlesungen. pp. vi+516. *figs. 31.* Jena: Gustav Fischer. 1909.

Heredity is recognized as only one of many factors involved in evolution, and the author does not even attempt to enumerate the other factors, discussing briefly only such other evolutionary factors as are directly related to the question of permanence of types, for example, natural selection, Weismannism, direct influence of environment, inheritance of acquired characters, etc. He dismisses all which are not based upon a clear distinction between the different kinds of variation and the different kinds of types as purely speculative, and therefore as having no place in the exact science of heredity.

The author recognizes that there may be several ways in which new biotypes come into existence, for example, by changes in the characters of the genes or determiners, loss of genes, combinations of different genes through hybridization, etc., but devotes relatively little attention to this phase of the subject.

While less than 100 pages are given to the results of genetic studies in mutation and hybridization, these subjects are treated in a very satisfactory manner. It is impossible in so short a space nearly to cover these fields in detail, and the method used is the same as in the biometrical part of the book, appropriate examples being introduced to illustrate each phase of the subject, no attempt being made to give a comprehensive account of the many investigations which have been made. With a detailed account of the recent work in Mendelian heredity, we are fortunately supplied at the present time by BATESON's most recent book[2] on the subject, which, together with this book by JOHANNSEN, gives us a practically complete discussion of what has been done in the study of heredity by exact scientific methods.

While JOHANNSEN's book is written in German, and is therefore less accessible to the entire English-reading public than might be wished, he has fortunately written with great simplicity and directness, and thus his work is more easily read than is often the case. The author has been criticized by German reviewers because of certain mistakes in German idiom, but the slight departures from the pure German idiom always occur in the direction of the Danish idiom, which is more nearly like the English; consequently, his book is more easily read by English readers than it would be if it followed the German idiom more closely. The value of the work is greatly enhanced by the fact that the author's discussions are illustrated at every point by detailed examples from his own incisive experiments. It is, therefore, a treasure-trove of new knowledge, leading to conclusions which are certain to have a large place in the future discussions of heredity and evolution. The book is worthy of a place beside DARWIN'S *Origin of species* and DEVRIES'S *Mutationstheorie*, and is certain to be rated as a classic example of the new spirit which has entered into biological investigation in the beginning of the twentieth century.—GEO. H. SHULL.

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[2] BATESON, W., Mendel's principles of heredity. pp. xiv+396. *pls. 6. figs. 37.* Cambridge: University Press. 1909.

Outlines of bacteriology

The scope of a work on bacteriology by ELLIS[3] is outlined in the following sentence of the Introduction: "This book is intended to serve as an introduction to bacteriology in all its branches, though more attention has been bestowed on that aspect of the subject which is of the most interest to students of technical and agricultural bacteriology."

Bearing the above introductory sentence in mind, the reviewer is the more impressed by the apparent "errors of omission and commission," the lack of facile expression, misstatements of fact, and in places the absence of a knowledge that denotes real intimacy with certain phases of the subject to be presented. And it is marvelous that the firm of Longmans, Green & Co., should have undertaken the publication of the volume.

Without touching upon numerous smaller mistakes and errors, attention may be drawn to the prominence given the author's views upon the supposed very general flagellation of the members of the Coccaceae (pp. 19, 20). It might be well to point out that those views are not yet by any means concurred in by many eminent authorities.

The crudity of the method recommended for the observation of the germination of spores (p. 32) is brought into relief when compared with the superior advantages afforded by the use of the hanging-drop, or the hanging agar-block on the warm stage.

In the light of the best American practice, the method advised for the handling of gelatin petri dish cultures is incomparably cumbersome and unnecessary (p. 47); while the strictures passed upon the use of agar under similar conditions are scarcely warrantable (p. 49).

In his discussion of the effect of the electric current upon bacterial life, it would seem that the author had not read far enough afield, else the statements made by Professor J. BEHRENS in LAFAR'S *Handbuch d. techn. Mykologie* (vol. I, sec. 99, p. 455) would have vastly modified his opinion.

Page 61 gives undue prominence to MELTZER'S ideas regarding the adverse action of moderate degrees of continuous vibration upon bacterial cells. It may be said that those views no longer carry weight.

In the chapter on sterilization (p. 85) are to be found the following remarkable statements in reference to the sterilization of the air of a room: "It may at once be stated that no gas is a disinfectant. . . . . Obviously, therefore, if we wish

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[3] ELLIS, DAVID, Outlines of bacteriology (technical and agricultural). 8vo. pp. xii+262. *figs. 134*. London: Longmans, Green & Co. 1909. *7s. 6d.*